The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

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THE CHEMICAL AGE offices are closed on Saturdays in accordance with the adoption of the five-day week by Benn Brothers, Limited

VOL. XLV. No. 1166 — November 1, 1941 — Annual Subscription, 21s. Overseas, 26s.

Artificial Manures

WITHIN this last year there has come to a head a debate of considerable importance to the chemical industry and to agriculture. There has arisen a vocal body of opinion among agriculturists that declares against the general use of artificial fertilisers as a means of revivifying spent land. The arguments put forward are not frivolous and are advanced by responsible persons of considerable repute in matters agricultural. In its most far-reaching form, this line of thought was thus summarised by Mr. F. C. R. Douglas, M.A., M.P., in a paper before the Royal Society of Arts in June last (*J. Roy. Soc. Arts, 89,* 572): "The methods of agriculture now practised in this country fail in greater or less degree to return to the soil the organic waste materials which are a by-product of the life of plant, animal, and man. This organic waste is the source of the humus which plays an important and essential part in soil fertility and in the nutrition of plants. Artificial fertilisers are applied to the land and these in many cases hasten the loss and destruction of humus. For the soil itself the most serious consequence is erosion, which may proceed to such a point that the cultivable layer is wholly lost and formerly fertile tracts become desert. Before this point is reached the conditions of life to which the plant has become accustomed during its long evolution are so changed by the lack of humus and the application of artificial fertilisers that its constitution is affected; it becomes susceptible to disease, and its value as food for man (whether directly or through animals nourished upon it) deteriorates."

Lord Northbrook, writing in *The Times* of August, 22, referred to the alleged bad effect of sulphate of ammonia dressing on corn land put on ley ground this year. Mr. Robert Sanders, supporting him, referred to a farmer ordered by the War Agricultural Committee to sow all his corn land with sulphate of ammonia in May last (at a cost of £100). "The result is that much of the corn is badly laid, the straw is weak, and the dressing has encouraged in an unusual manner the growth of weeds and grass undermath since the wet weather commenced." Lord Bledisloe regards as short-sighted and injudicious "the attempt in a humus-starved country like England to seek recovery from exhausted land fertility, especially in our widespread waterlogged areas, by substituting chemical fertilisers for animal and vegetable residues." Even more disastrous, he considers "will be the tendency to upset the balance of plant nutrients in the surface soil by heavy doses of sulphate of ammonia or other nitrogenous dressings as compensation for the war-time scarcity of phosphatic, and the almost entire absence of potassic, fertilisers."

On the subject of chemical fertilisers, Mr. Douglas (*loc. cit.*) was caustic: "The farmer," he says, "was presented with a substitute for manure in the form of artificial fertilisers. He was assured by chemists and biologists, who had not yet realised the infinite complexity of processes which they thought could be reduced to terms of elementary chemistry, that these fertilisers contained all that the plant required. The manufacture of artificial fertilisers became a new and profitable industry, using up in some cases the by-products of other chemical industries. . . . Artificial fertilisers often gave more luxuriant growth and larger crops, and therefore a larger return to the farmer. They were, especially in the initial period, merely a supplement to manure. The humus in the soil was not rapidly depleted. No danger signal manifested itself to the farmer, and still less to the urban population. It is only recently that serious anxiety has become aroused about the condition of the land and its consequences for agriculture and health."

In the views of the authorities just quoted the solution of the difficulty is to utilise the process to which reference was made in THE CHEMICAL AGE of February 8 last (p. 83), in which the organic refuse from towns is treated at sewage works and returned to the land in the form of artificial manure. Again, to quote Mr. Douglas: "The problem cannot be solved by merely dumping sewage and house refuse upon the land, primarily because neither of these is in a condition in which within a reasonable time they will turn into humus, and, secondly, because they are not, as they are produced, in a condition which is pleasant to handle. What is required is that both these forms of waste matter should be handled and treated on a fairly large scale so that they are turned into humus before they are offered to the farmer. They must be combined to form a manure which is cleanly and convenient to handle, which can be stored for a reasonable period of time without being offensive, and which is ready to perform its beneficial work for the plant as soon as it is applied to the land without undergoing a further process of composting before it becomes available to the plant. It is also necessary that the value of the product should be tested and demonstrated by properly conducted experiments in the cultivation of the principal crops of commercial importance. A fertiliser which conforms to the conditions indicated is certain to command a substantial price when the prices now paid for artificial fertilisers are borne in mind. This should afford a sufficient margin to cover the additional costs which the local authority will have to bear."

As against this view, there is the now well-known method of soil-less culture which, as Prof. Salisbury

points out, shows that under certain conditions humus can be satisfactorily dispensed with. He emphatically denies that there is any satisfactory evidence that the use of artificial manures necessarily encourages disease. "If properly employed and not abused they serve to replace the nutrients that the growing crop is continually removing from the reservoir that the 'humus' plays so large a part in maintaining. An intelligent use of mineral fertilisers demands not only a proper appreciation of their balanced supply, but also of the rôle which 'humus' exerts in their retention and release." Other writers point out that there is plenty of evidence on all sorts of soils that good cultivation plus balanced fertilisers will grow good and healthy crops indefinitely.

Wherein lies the truth amid these conflicting ideas? Is it that chemists, biologists, and scientific agriculturists have misled themselves and those dependent on their advice for several decades? Or is it that the older school does not recognise the conditions under which artificial manures should be used? Fertilisers to-day, as Parrish and Ogilvie justly remark in their book on Calcium Superphosphate, "must contain more than the three most indispensable elements, nitrogen, phosphorus and potassium. At least eleven other elements are indispensable to plant growth. These are calcium, carbon, hydrogen, oxygen, magnesium, iron, sulphur, manganese, boron, copper and zinc. Apart from the removal of the three principal elements by crops, calcium is withdrawn in larger quantity than any of the ten minor or trace elements. Carbon, hydrogen and oxygen are obtained by plants from air and water. With continual cropping, it has become apparent that certain soils are deficient in one or more of the remaining seven elements."

This has been an exceptional growing year, and the extent of the growth has been the cause of the relative weakness of the straw that was experienced in some places. There was no such trouble last year even though chemical fertilisers were applied generously. This year the trouble has not been confined to fields where sulphate of ammonia was used, and some of the weak straw has been found on land newly ploughed out of old grass and therefore rich in humus. Chemical fertilisers used in accordance with the best practice can greatly increase the yield of crops, and if it is necessary to grow the stiffer-strawed varieties of corn to compensate for difficult seasons, there is no reason why this modification should not be introduced as a scientific development of the extensive use of chemical manures.

We have advanced a long way in making up artificial manures since the day when sulphate or phosphate was applied alone to land in the belief that it was all-sufficient. A really balanced fertiliser will have to be built up in accordance with soil analysis, and agriculture must be conducted with the aid of the soil analyst and of the fertiliser chemist. Science must take a larger share in agriculture than hitherto dreamed of. Whether the replacement of humus is essential remains to be seen. Experiments are in progress at Reading University which may settle that vexed question. At the same time the chemical industry might well take a hand in the new form of sewage disposal visualised by the exponents of humus replacement, using the material thus obtaind as the basis for a complete fertiliser mixture.

NOTES AND COMMENTS

Japanese Phosphate Difficulties

WHATEVER the opinion concerning the use of chemical fertilisers in this country may be, there seems no doubt that the Japanese situation in this respect is causing the Tokyo government considerable anxiety. The question of fertiliser supply would appear to be one of the many reasons for Japan's aggressive attitude in Indochina. Former sources of fertiliser supply have been cut off and so far the results of repeated efforts to increase importation of phosphates and to raise production of ammonium sulphate have been negligible. According to the information of the U.S. Bureau of Mines, Japan has been looking towards Chosen (Korea), China, and Indochina for new phosphate sources. Plans are said to have been made to develop on a large scale apatite deposits in both China and Indochina. Recent observers in French Indochina say that the most important sources of phosphate are the hardly scratched deposits of the Lao Kay region, where it has been estimated that there are at least 10,000,000 tons of high-grade rock in reserve. There are many other sources of phosphate rock and apatite in other parts of Indochina. Mining of some of those not worked previously was begun in the past year. Two of the mining companies are backed by Japanese capital, and the output is shipped to Japan for refining. According to *Minerals Yearbook*, 1940 (Bureau of Mines), phosphate-rock production in French Indochina in 1939 was 35,694 metric tons. In Chosen efforts are being made to increase production not only to meet the demand from Japan, but also to satisfy domestic requirements, as there is already a shortage of fertilisers in Chosen. It is expected that the production of phosphate rock from the two chief deposits—at Tansen, Keiki Province, and Kaijito, North Heian Province—will be about 60,000 tons in 1941. Transport continues to be a difficult problem, however.

Ammonium Sulphate Shortage

THE ammonium sulphate industry in Japan is in not much better shape. Government aid in many forms has not been enough to restore production to anything like the pre-Chinese-war level. It appears that the production for the year August, 1940-August, 1941, will have been about a million metric tons, some 300,000 tons below the normal. A process for extracting ammonium sulphate from bittern obtained by boiling sea water is said to have been invented by a professor at the Tokyo University of Technology. Although this discovery has received considerable publicity in the Tokyo Press, it is not thought probable that its use would prove commercially feasible in Japan at present. Furthermore, a severe frost in late spring this year devastated the mulberry farms in North and Central Japan and necessitated an unscheduled distribution of fertiliser to farmers, amounting to some 5000 tons of ammonium sulphate and Chilean nitrate.

Priority for War Work!

IN view of the urgent need for the intercommunication of British and American manufacturers engaged in war work, and their passage across the Atlantic, the following paragraph, from a London daily newspaper of wide circulation, should be of great interest to the chemical industry. We reprint it without further comment. " Bebe Daniels and Ben Lyon, stranded at Lisbon on their way from America to London, will hear soon that priority has been arranged to enable them to arrive in England in time for the rehearsals of ' Hi-Gang,' scheduled to open on November 9. The Ministry of Information knows that their non-arrival would cause disappointment to millions of listeners, and has arranged with the Civil Aviation authorities to secure them seats on a plane to England."

(CONTENTS *appears on p. iv.*)

Iron Catalysts for Ammonia Synthesis

Secondary Importance of Physical Properties

MANY and various catalysts have been suggested and patented for use in the synthesis of ammonia. In addition to a chemical difference they differ also in the mode of preparation, and it is a general belief that the latter is almost as important as the former. N. I. Kobosev (*J. Phys. Chem. Russ.*, 1940, *14*, 650) points out that, provided that the chemical composition is kept constant, the physical properties of the catalysts are of secondary importance.

Kobosev prepared three sets of iron catalysts, *viz.*: (1) finely ground Fe_3O_4 reduced by heating to 300-450°; (2) iron pentacarbonyl mixed with ash-free charcoal and decomposed by heating; and (3) asbestos soaked in iron carbonyl and heated till the complete destruction of the $Fe(CO)_5$. These catalysts were used for synthesis of NH_3 from streaming H_2 and N_2. As a measure of the catalytic activity the product $k = x\sqrt{v}$ was used, x being the percentage of NH_3 in the outgoing gas and v its velocity. It was found that k increased with the amount of iron per gram of charcoal or asbestos in much the same way. At a constant iron content the charcoal catalyst was more efficient than the asbestos catalysts; the difference was due, however, only to the difference of the surface areas of these supports, which caused also the difference in the adsorption capacity of charcoal and asbestos. When much $Fe(CO)_5$ was used, the efficiency k of both charcoal and asbestos catalysts was very near to that of reduced Fe_3O_4.

The efficiency increased with the iron content p of the catalyst in such a manner that the "specific efficiency" k/p passed through a maximum. For charcoal this occurred when the charcoal surface was covered to 0.06 per cent. by iron at 450°; at 400° the most efficient covering was 0.6 per cent., and at 350° 6 per cent. As the surface area of the asbestos was not known quantitatively it was impossible to calculate the most efficient covering. But the iron content p at which k/p had a maximum value was, for asbestos, independent of temperature. This is the only difference between the catalysts on charcoal and those on asbestos which cannot be ascribed to the disagreement of the surface areas.

When kept at 500° C. the catalysts lose a part of their efficiency. The speed at which k decreases is almost independent of the support and of the percentage of iron in the catalyst. It is practically identical with that observed by Mittasch (1932) on pure iron powder. That is the most convincing proof of the identity of active units in various preparations of iron catalysts.

Synthesis of ammonia is retarded by an admixture of oxygen to the hydrogen-nitrogen gas. The equation $x\sqrt{v} =$ const., in which y is the percentage of oxygen in the gas, is valid for iron on charcoal or asbestos as well as for pure iron. The numerical value of the constant is also the same for various preparations.

War Damage

New Arrangement for "Conditional Notice"

by FRED J. TEBBUTT

THE Landlord and Tenant (War Damage) Act, 1941, alters the 1939 Act of the same name in the light of experience gained since its passing (which was before war damage had occurred), but really concerns the relationship between landlord and tenant and not compensation for damage, which is another matter and is covered by the War Damage Act, 1941. The 1939 Act provided that where premises are made unfit for use by war damage, a lessee can give up the lease by serving on the lessor a "notice of disclaimer," that is if the landlord accepts same; if the landlord, however, wishes the lease to continue he serves a "notice to avoid disclaimer" in return, at the same time making himself responsible for rendering the premises fit for use. If on the other hand the lessee wishes to retain the lease, as he may very well do with a favourable one, he serves a "notice of retention," but the tenant is then responsible for making premises fit for use.

In connection with the "notice of retention" provision, an eventuality has been envisaged consequent on the War Damage Act, 1941. Under that Act, if premises are considered capable of repair, a cost-of-works payment is made, really covering "cost of repairs"; if, however, repairs are considered inexpedient a "value payment" is made, payment of this being in the hands of the War Damage Commission of the Act concerned. The position therefore is that if a lessee serves a retention notice, being then responsible for making premises fit for use, he would probably be reimbursed for his outlay if a "cost of works" payment is decided upon. But if the Commission decides on a "value payment," then the landlord would receive most, if not all, of the payment, although the lessee would, by the retention notice, have become liable for rebuilding.

Therefore the 1941 Act brings in another notice, a "conditional notice of retention," which can apply as a "notice of disclaimer" if a "value payment" is determined upon, if a statement to this effect is included in the notice and a copy is sent to the War Damage Commission likewise, within one month of serving upon the landlord. Furthermore, if a notice of retention has been served before the 1941 Act became law (August 7, 1941), that notice can become a "conditional notice of retention" if the landlord is notified similarly as above, before November 7, 1941, and the Commission within one month afterwards.

This new Act takes out of the "notice" provisions of the 1939 Act, short leases (meaning tenancies which can be terminated by three months' notice or less), the position, of course, being that such tenancies can be terminated at any time, according to the notice requried. But rent is ordinarily payable until the end of the relevant notice period. The new Act now provides that where war damage occurs no rent is then to be payable if the premises are not occupied; but if the premises are occupied, although having suffered war damage in whole or in part, a rent can be charged, which, failing agreement between the parties as to the amount, can be fixed by the county court. Such a tenancy, however, cannot remain alive for an indefinite time, as the court can determine the tenancy after a period of three months from the time when the premises have been made fit for use, if the landlord satisfies the court that the premises have not been occupied either in whole or in part, no rent has been paid, and that he has made all reasonable efforts to get in touch with the tenant without success. Goods left on the premises or the retention of the keys by the tenant do not constitute occupation under his provision.

The Australian Government has decided to erect four distilleries, costing about £1,250,000, for the production of power alcohol from wheat. They will be in N.S.W., Victoria, South Australia, and Western Australia, and each will have a productive capacity of 3,000,000 gallons a year.

PETROLEUM CHEMISTRY

Papers of the American Chemical Society

BY courtesy of the American Chemical Society we are able to publish abstracts of a selection of the papers presented this year before the Division of Petroleum Chemistry of that Society. The meeting was held at Atlantic City, New Jersey, on September 8-12.

A method for the "Determination of Inorganic Salts in Crude Oil" is described by E. P. Rittershausen and R. J. DeGray, General Laboratories, Socony-Vacuum Oil Company. The tetraethyl lead extraction apparatus is used to extract the inorganic salts with water. The water extract is titrated for chloride content in conventional manner. The method offers no saving in time for one sample, but with a battery of three extractors the average time per sample is less than that needed for previous methods. Duplicate determinations by one operator check to within 2 lb. of NaCl per 1000 bbls. of crude. Harry Levin and Ervin Stehr, The Texas Company, Beacon, N.Y., outline a method for determining free sulphur in lubricating oil, which involves dissolving the sample in benzene and acetone, refluxing with copper to fix the sulphur as sulphide, and determining its available hydrogen sulphide iodometrically. Special precautions and apparatus were found necessary to avoid loss of hydrogen sulphide. A simple accurate method for determining organically combined phosphorus in lubricating oil is described by Harry Levin, F. F. Farrell, and A. J. Millendorf, The Texas Company, Beacon, N.Y. It involves ignition of the sample with sodium naphthenate which serves to bind the phosphorus in inorganic water-soluble form. The water solution of the phosphate is reacted to form ammonium phosphomolybdate which is centrifuged and the phosphorus calculated from the volume of precipitate.

Improved Viscometer

The increasing importance of accurately determined viscosities of petroleum products is causing widespread adoption of capillary-tube viscometers in the industry. A paper by Frank C. Croxton, Battelle Memorial Institute, Columbus, Ohio, describes a viscometer which was designed to bring together almost all the advantages of the various earlier instruments. A vapour thermostat is equipped with an interchangeable ground joint, so that any of a series of Zeitfuchs-type viscometer parts may be used therein. An equation for calculating the capillary size necessary to approximate a desired viscometer constant is given. The more important features of the instrument are its accuracy, flexibility, and speed in combination with low cost.

Within the last decade a number of investigators have determined the solubilities of nominally gaseous hydrocarbons in liquid hydrocarbons. Although the data obtained extended to relatively high pressures, the temperatures of the determinations seldom exceed 120° C. A paper by V. N. Ipatieff and G. S. Monroe, Research Laboratories, Universal Oil Products Co. outlines a method for determining solubilities at high pressures and at high temperatures by means of a modified rotating bomb. The results obtained by the method are given for the solubilities of methane and propane in benzene. The solubility of sulphur dioxide in benzene at 26° C. over a pressure range of 1.20 to 2.65 atm. (abs.), determined by the same method, is also included. A study of the pressure-temperature relationship of pure substances was made using the same type of bomb. Points of discontinuity appeared on the pressure-temperature curves in the region of the critical temperature. The pressure-temperature curves of two component systems also exhibited similar points of discontinuity. This suggests a method for determining critical temperatures.

"The Molecular Volume of Liquid Alkanes at Corresponding Temperatures" was dealt with by Gustav Egloff and Robert C. Kuder, Universal Oil Products Company Research Laboratories, Chicago. The comparison of the molecular volume of hydrocarbons at their boiling points or melting points suffers from the fact that these temperatures are not exactly constant fractions of the critical temperatures. When the normal alkanes are compared at exactly corresponding temperatures between their melting points and boiling points it is found that the molecular volume is an additive function with no complications from the alternating factor. In the equation $V = a + bn$ (where V represents the molecular volume and n the number of carbon atoms in the molecule) a is a linear function, and b a parabolic function, of the reduced temperature. A resulting practical application is the prediction of the density of butane below its boiling point.

The four aromatic hydrocarbons, 1,2,3,4-tetramethylbenzene, 5,6,7,8-tetrahydronaphthalene, 1-methyl-5,6,7,8-tetrahydronaphthalene, and 2-methyl-5,6,7,8-tetrahydronaphthalene, have been isolated by B. J. Mair and A. J. Streiff, American Petroleum Institute Research, from the kerosene fraction of petroleum by azeotropic distillation and fractional crystallisation. "Best" lots of each of these four hydrocarbons from petroleum were prepared and synthetic samples of three of them were purified for purposes of identification and determination of properties. Accurate values for the boiling point, freezing point, density, and refractive index for the C, D, and F lines extrapolated to zero impurity were determined for these four hydrocarbons.

Deterioration of Lubricating Oil

A new laboratory method for evaluating the deterioration of lubricating oils in engines is described by R. E. Burk, E. C. Hughes, W. E. Scovill, and J. D. Bartelson, Standard Oil Company of Ohio. The design is based upon a quantitative adjustment to the oil volume of the important factors influencing oil deterioration in engines. An arrangement provides a scrubbing action on catalytic surfaces induced only by the air used for aeration. The effects of these factors and of test variables are examined. The results are shown for a number of known types of oils. The correlation of such results with engines and the evaluation of detergency and bearing corrosion by this procedure are described.

Oxidation of Hydrocarbons

From a study of the oxidation characteristics of pure hydrocarbons, useful information has been obtained by R. G. Larsen, R. E. Thorpe, and F. A. Armfield, Shell Development Company, on the effects of structural factors upon oxidation stability. It was found that all saturated hydrocarbons, paraffinic or cycloparaffinic, behave similarly and are quite reactive. The aromatics containing a benzene ring attached to a saturated side chain or hydroaromatic ring are still more reactive, owing to the activating influence of the aromatic ring. In contrast, naphthalene and other polynuclear aromatics are very stable, apparently as a result of the formation of effective inhibitors upon oxidation. It is concluded that stability of a lubricating oil results not from stability of the basic hydrocarbons but from content of natural inhibitors.

Since the advent of commercial catalytic cracking of petroleum to produce gasoline there has been much speculation as to the reason for the high octane number of this material as a motor fuel over fuels produced by thermal cracking, and over those occurring in nature as straight-run gasolines. Work presented by J. R. Bates, S. S. Kurtz. junr., F. W. Rose, junr., and I. W. Mills, Sun Oil Co., shows that this is due to the presence of an overwhelming excess of *iso*paraffins over normal paraffins in the lower boiling portions of the gasoline and to a high content of aromatic compounds in the higher boiling fractions. The olefine content of catalytic gasolines can be varied widely, with only a secondary effect on fuel quality.

"High-temperature Alkylation of Aromatic Hydrocarbons" is the title of a paper by A. N. Sachanen and A. A.

O'Kelly, Socony-Vacuum Oil Co. Aromatic hydrocarbons, *e.g.*, benzene and toluene, have been alkylated with olefines at high temperatures of 800° F. and above. This process was performed under atmospheric pressure and in the absence of catalysts, but high pressures and such catalysts as activated clay improved the yields of alkyl aromatics. Toluene is more easily alkylated at these temperatures than benzene. On the other hand, propylene and butylene are stronger alkylating agents than amylene. Under high temperatures the alkyl aromatics produced were partially cracked, forming alkyl aromatics of lower molecular weight. As a result, the alkyl aromatics formed were composed of an entire series of aromatics beginning with toluene and increasing in molecular weight. The alkyl aromatics produced contained 90 per cent. or more of purely aromatic hydrocarbons.

Mechanism of Catalytic Action

Importance of Rapid Desorption

SEVERAL investigations have dealt with the relation between the efficiency of a catalyst and its ability of adsorbing the substances of which it accelerates the transformation. It is generally assumed that if a catalyst promotes a reaction between two substances the adsorption of at least one of them is a necessary prelude to the reaction. N. I. Pevni (*J. Phys. Chem. Russ.*, 1940, *14*, 981) points out that the desorption of the reaction product is as important as the adsorption of the initial substances; if the reaction product does not leave the catalyst quickly enough, the latter is blocked, and the reaction must stop.

Pevni compared five technical catalysts used for oxidation of SO_2 to SO_3. They adsorbed sulphur trioxide from its vapour at 450-500° C., and at both temperatures the order of decreasing rate of adsorption was: barium-vanadium catalyst, barium-aluminium-vanadium catalyst, chromium-tin catalyst activated by antimony, platinised asbestos, and platinised silica gel. After SO_3 vapour was kept in contact with the catalyst for 4 hours, the vessel was evacuated. The amount of SO_3 liberated was, however, much smaller than that previously adsorbed. In two minutes at 450° and 500° respectively, 9-16 per cent. and 13-17 per cent. of the SO_3 adsorbed were given off. The percentage of SO_3 which could be recovered after evacuation for several hours was in all cases less than 44 per cent. The rate of desorption at 450° decreased in the order: chromium-tin catalyst activated by antimony, platinised asbestos, platinised silica gel, barium-aluminium-vanadium catalyst, and barium-vanadium catalyst. The order of the catalytic efficiency of these catalysts, starting from the most powerful was, at 450°: chromium-tin, barium-aluminium-vanadium, platinised catalysts, and barium-vanadium. It was almost identical with that covering the rate of desorption of SO_3 and quite different from that observed for adsorption. At 500° there was practically no difference between the catalysts from the points of view of both desorption and of catalytic activity.

Synthetic Hormones

Derivatives of Diphenyl Hexanes

COMPOUNDS with the properties of follicular hormones are prepared, according to a recent patent of the Laboratoires Français de Chimiothérapie (F.P. 855,879), by heating a hydrohalide of certain propyl or propenyl phenols with sodium or potassium in presence of an inert solvent such as benzene. The new products may be regarded as hydroxy derivatives of diphenyl hexanes. Anethole hydrobromide, for example, is converted by way of 4,4¹-dimethoxy diphenyl hexane into 4.4¹-dihydroxy diphenyl hexane (m.p. 182° C.). Another starting material for the synthesis is propenyl-3,4-veratrol hydrochloride which yields 3,3¹,4,4¹-tetramethoxy diphenyl hexane, the latter then undergoing demethylation to 3,3¹,4,4¹-tetrahydroxy diphenyl hexane.

Some Uses for Rare Earths

Widening Scope in the Glass Industry

OWING to the close similarity in electronic structure of the rare earths they tend to occur as a group rather than as isolated compounds. In other words, a mineral containing one rare earth will in all probability contain the other rare earths also. The percentage composition of the earths, however, may vary according to the source mineral. The only commercial source of the rare earths at present is monazite, which is obtained mainly from British India and Brazil. In 1938 world production of monazite was a little over 6000 metric tons. Of this quantity, India supplied 5305 metric tons, Brazil 323 metric tons, and the Netherlands Indies 393 metric tons.

The U.S. Bureau of Mines, in a recent issue of *Mineral Trade Notes*, gives a review of some recently-developed uses of the rare earths and their compounds. When a mixture of these elements is reduced to the metallic stage, there is formed an alloy known as mischmetall. Mischmetall, when alloyed with iron, is familiar as the sparking flint on cigarette lighters. Mischmetall is also used in tracer shells and tracer bullets, the combustion of the metals providing a brilliant light at night. The alloy is also used to some extent in photo-electric cells and in detonators. Because of the superior heats of formation of the rare-earth oxides, mischmetall has been proposed as a substitute for aluminium metal in thermite incendiary bombs. The mixed oxides and mixed compounds of the rare earths find an outlet in fluorescent paints, as catalysts, in carbon electrodes for sun lamps, and in proofing against mildew.

Lanthanum has been used in an aluminium piston alloy. Its compounds are useful as catalysts, for weighting silk and rayon, in ceramics, in non-silicate optical glass, as bactericides, and in nail-polishing preparations.

Cerium Compounds

Cerium is utilised in goggle lenses for soda-glass workers as it absorbs the yellow line in the sodium spectrum. Cerium fluoride and cerium oxide are used in stabilising carbon arcs. Cerium oxide is used for colouring topaz, in opacifying enamels, in fluorescing glasses for mercury-vapour discharge tubes, in X-ray tubes, and in glass for the absorption of ultra-violet spectra. Cerium compounds have been employed in moth-proofing fabrics, as chemical reagents (ceric sulphate) in mildew-proofing, in photography, as catalysts, in driers, and in leather tanning. Cerium fluoride has found favour as a coating for filter-press cloths to protect against the corrosive action of acid liquors and vapours. Cerium oxalate has been proposed as a medicine in the treatment of seasickness, and cerium nitrate has been suggested as a bactericide. Cobalt and cerium oxides give a blue colour to glass, while chrome and cerium oxides impart a green colour. Cerium metal is used in welding electrodes, as a catalyst in starting organic reactions, in the reduction of columbium metal, and as a gas purifier in the manufacture of neon tubes.

Neodymium and Praseodymium

Praseodymium oxide gives glass a yellow-green colour; neodymium oxide colours it purple; the mixture of the two oxides (formerly known as didymia) provides a neutral grey tint. Reds and blues in a landscape appear deeper when viewed through neodymium glasses. This quality is important in measuring and surveying. Neodymium in windshields reduces the glare of transmitted light, and it has also been used to decolorise glass, perhaps oxidising green ferrous iron to colourless ferric iron. It is used in the manufacture of "neophane" glass for yellow sunglasses and in glasses that apparently have the property of correcting incomplete colour-blindness. Praseodymium, which is more expensive than neodymium, is used to a very small extent in telescope screens to cut out certain undesired spectra.

Europium compounds have been suggested for fluorescing tubes, while erbium compounds have been proposed as medicinal astringents.

Personal Notes

MR F. CECIL BAKER was recently elected president of the American Potash and Chemical Corporation.

LIEUT.-COLONEL B. J. EATON, O.B.E., F.I.C., F.I.R.I., is to be presented with the Colwyn Gold Medal for 1941.

MR. C. J. OSBORN, of Melbourne University, has been awarded the Australasian Institute of Mining and Metallurgy Prize for 1940 for the best paper submitted on a mining or metallurgical subject.

MR. E. R. BEHNE, of Brisbane, a member of the Australian Chemical Institute, and technologist in the Bureau of Sugar Experimental Stations, has been awarded the H. J. Smith Memorial Medal for 1941, for his outstanding work in the last ten years in connection with sugar research.

MR. BENJAMIN JAMES WILSON, head of the mechanical division research department of the Leeds and Northrup Co., Pennsylvania, was recently presented with Longstreth Medal by the Franklin Institute for his development of an integrating and recording flowmeter.

MR WILLIAM ALEXANDER PULLAR, works manager, and MR. JOHN SCOTT, millwright, both of Glasgow, have been awarded the Edward Medal for their gallant conduct after an explosion at the starch works of James Morrice (James Anderson and Co.), Ltd., Surrey Street, Glasgow, on October 24 last year. They made repeated attempts to rescue trapped employees from the burning building, stopped the machinery, and drew the boiler fires, thus preventing a further explosion.

Obituary

MR. GEORGE STAFFORD ALLEN, who died suddenly at Long Melford, Suffolk, on October 22, aged 70, had been a director of Stafford Allen and Sons, Ltd., manufacturing chemists, of London and Long Melford, since 1900. He was the son of the late Edward Ransome Allen, and is of the third generation of his family in the business of Stafford Allen and Sons, Ltd., having started in the family business in 1890. Until his death he was resident director at the Long Melford Works, Suffolk, and had for many years been a J.P. for the County of Suffolk.

New Control Orders

Exports of Iron and Steel and Neoprene

LICENCES will in future be required for the export to all destinations of a number of different forms of iron and steel, including alloy steel, and of articles manufactured from them. This is contained in an order (S.R. and O. 1941, No. 1615), which comes into force on November 6. It also prohibits the export of neoprene and articles manufactured from it, except under licence, and extends the existing prohibitions relating to borax, and boric acid.

Purchase Tax : Drugs and Water Softeners

The Purchase Tax (Exemptions) (No. 1) Order, 1941, which has been made by the Treasury, defines the scope of the exemption for certain drugs and operates from November 3. A new Notice (No. 78 B) has been issued by the Customs and Excise Department which includes the schedule of exempt drugs and an explanation of the scope of the exemption. Copies are being supplied to all registered traders likely to be concerned, but if a copy is not received by November 1, application should be made to the local Officer of Customs and Excise. The Schedule of exempt drugs includes bromethol, chloroform (anæsthetic), cyclopropane, ether (anæsthetic), ethyl chloride, nitrous oxide, oxygen, and a long list of medical preparations.

All domestic and general purpose types of water softener, irrespective of their capacity or of the materials of which they are made, are chargeable with Purchase Tax; but water softeners supplied to specification for purely industrial purposes, *e.g.*, to public laundries, dairies, breweries, etc., are exempt. This decision will apply to all goods delivered on or after November 1, 1941.

Chemical Matters in Parliament

War Inventions

IN the House of Commons last week, Major Lyons asked the Lord President of the Council whether, in view of the present limitations of the smaller manufacturer, he was satisfied that the Department of Scientific Research provided adequate facilities for the manufacture and test of likely inventions and forms of apparatus which might be submitted to it for war purposes; and whether he would make available in approved cases a number of small factories able to undertake general work of that kind.

Replying, Sir J. Anderson said that inventions and suggestions for war purposes submitted to the department were immediately sent forward for expert examination by the appropriate ministry. He was satisfied that the existing organisation of the department was adequate to carry out the preliminary sifting required. Answering a further question, Sir John denied that there was any justification in the view that the public were hindered from submitting suggestions to the department.

Raw Materials Control

Captain Plugge asked the Parliamentary Secretary to the Ministry of Supply, to what extent each of the various commodity controls was provided with scientific advisers, and to what extent they had arrangements to obtain other scientific advice.

The Raw Material Controls, replied Mr. Harold Macmillan, were equipped with staff competent to deal with all day-to-day technical questions, and on questions involving scientific research and development they had full access to the Advisory Council on Research and Development. Under existing arrangements, the advice of any other scientist and consultant in the country could be obtained when required.

British Chemical Prices

Market Reports

MARKET conditions generally are reported to be comparatively quiet this week; nevertheless, a substantial movement to the main consuming industries is reported mostly against contracts, and dealers are well booked for some time ahead. Values on the whole continue steady, and quotations have moved within narrow dimits. An active interest has been displayed in the majority of the soda products, with bichromate and chlorate in strong request. With the exception of permanganate of potash, which is also very active, offers of most of the potash materials are scarce, and in some instances nominal quotations only are ruling. Among the heavy acids, sulphuric, hydrochloric, and acetic are active items, while a good demand persists for available quantities of tartaric and citric acids. In the coal tar products market values continue steady to strong; offers of naphthalenes are absorbed for priority needs and spot parcels of cresylic acid are almost unobtainable.

MANCHESTER.—Chemical market values are mostly on a strong basis, and while new buying is not particularly brisk at the moment the principal contract users are specifying for steady deliveries, which cover good quantities in the aggregate. In quite a number of products prompt offers are becoming increasingly difficult to secure. Among the tar products crude tar, creosote oil, both crude and crystallised carbolic, the general run of light products, and the naphthalenes are all in active demand and firm price conditions obtain.

GLASGOW.—The Position in the Scottish heavy chemical trade is unchanged since last week both in the home and export business. Prices remain firm, but where altered are dearer.

Price Changes

Bleaching Powder.—Spot, 35/37%, £10 17s. 6d. per ton, in casks, special terms for contract.

Carbolic Acid.—MANCHESTER: Crystals, 9½d. to 10¾d. per lb., d/d; crude, 4s. 3d. to 4s. 6d., naked at works.

Chrometan.—Crystals, 5½d. per lb.; liquor, £24 10s. per ton, d/d, station in drums.

Sodium Bisulphite Powder.—60/62%, £18 15s. per ton, d/d, in 2-ton lots, for home trade.

Sodium Sulphide.—Solid, 60/62%, Spot, £17 15s. per ton, d/d, in drums; crystals, 30/32%, £11 15s. per ton, d/d, in casks.

Sodium Sulphite.—Anhydrous, £29 10s. per ton; Pea crystals, spot, £19 10s. per ton, d/d, station in kegs; commercial, £13 5s. per ton, d/d, station in bags.

Metallurgical Section

November 1, 1941

ALUMINIUM ALLOYS

Their Possibilities of Future Development

by OTTO EINERL, Dr.Eng., and FREDERIC NEURATH, Ph.D.

THE beginning of the aluminium industry dates from 1886, when Héroult in France and Hall in America applied indepently for patents covering its technical production. About the same time, the Cowles brothers succeeded in producing copper-aluminium alloys by reduction of alumina in an electric furnace in the presence of copper. These alloys, the first aluminium casting alloys in use, later became known as "American Alloys." But as the purity of the aluminium and its alloys still left much to be desired, especially as regards the iron content, practical application was hindered; in addition the price of aluminium was still high at £1200 per ton in 1890. In the last years of the nineteenth century, however, the price of aluminium dropped to under £200 per ton, while at the same time the beginning of magnesium production initiated the development technically usable of magnesium-aluminium alloys. Later the introduction of zinc into the aluminium-copper alloys started the so called "German Alloy" which could be used both for sand and die castings and had a permissible iron content of up to 1 per cent.

Progressive improvement in purity of the aluminium metal made possible the invention of the first aluminium rolling alloy, "Duralumin," by Alfred Wilm in 1906, whereby the first aluminium alloy that could be hardened came into being. Duralumin is a copper-aluminium alloy with an addition of magnesium and manganese. Practically pure aluminium was produced in 1919 by Hoopes, while in 1920 Aladar Pacz (U.S.P. 387,000 and 410,461) patented the "modification" of the aluminium-silicon alloys by means of sodium, these silicon alloys then being produced as casting and rolling alloys under the names "Silumin" (Germany), "Alpax" (France), "Alloy 47" (America), "Birmasil," L 33, and M.V.C. Alloy (England) on a large scale.

The introduction of nickel into aluminium-copper alloys by the National Physical Laboratory in Teddington created the "Y-alloy" (Rosenhain, *J. Inst. Met.*, 1923, 29, p. 191), which from 1927 on was overshadowed by the introduction of the "RR-alloys" (Rolls Royce Co., Ltd.). The RR-alloys are also copper-nickel-aluminium alloys, containing apart from an addition of 2 to 3 per cent. silicon some iron, which in this case, is added on purpose to the extent usually of over 1 per cent., whereas in nearly all other aluminium alloys iron is still considered detrimental.

Aluminium Production Figures

Hardly any other metal has ever shown so rapid an increase in consumption as aluminium. The following figures indicate world production of aluminium:

1890	300 tons
1900	7,000 tons
1913	64,000 tons
1925	180,000 tons
1935	260,000 tons
1938	570,000 tons
1939	680,000 tons

There is no doubt that world production during the war has risen still further, but correct figures are not yet available. The following comparison of the figures for the years 1925 and 1938 with the estimated production for 1939 is interesting.

Source.	Production in Tons. 1925	1938	1939
Great Britain	10,000	25,000	25,000
U.S. and Canada	80,000	165,000	225,000
Germany	27,000	180,000	205,000
Russia	—	50,000	55,000
Rest of Europe	63,000	130,000	140,000
Japan	—	20,000	?
Total	180,000	570,000	680,000

In 1940 the output in the United States and in Canada (the largest aluminium producer within the Empire) was running at an annual rate of 350,000 tons. By early next year the rate should exceed 500,000 tons per annum.

Bauxite

Raw material used for the production of aluminium consists almost entirely of the bauxites (containing about 55-65 per cent. Al_2O_3, approx. 28 per cent. Fe_2O_3, up to 4 per cent SiO_2 and 12-30 per cent. water) of which about 4 tons are necessary for 1 ton of aluminium. The world production of bauxite in 1938 is shown in the following table:—

France	680,000 tons
Italy	380,000 tons
Germany	90,000 tons
Balkan States	1,000,000 tons
Russia	250,000 tons
U.S.A.	430,000 tons
Brit. and Dutch Guiana, Dutch East Indies	1,000,000 tons

About two-thirds of the bauxite mined is utilised for making aluminium, the remaining third being used by the oil-refining and chemical industries, for refractories and alumina cement.

At present about 90 per cent. of the aluminium is being produced by the Bayer process. By this and also by the other methods, the reduction of the raw material is done electrolytically, the electrolyte being a mixture of cryolite (Na_3AlF_6) and alumina. The consumption of current necessary for this process is exorbitant and the increase of the aluminium output was accompanied by a rapid exploitation of water power in various countries. The world production in 1938 of 570,000 tons required a total current consumption of 11,400 million kWh, and 240 million working hours per year were necessary for the current generation for the production of aluminium oxide (Al_2O_3) from bauxite and for the electrolysis of the cryolite-alumina mixture. These figures will, to all appearances, have to be nearly doubled for 1942 or 1943.

The ratio of world aluminium production to world copper production has risen from 1 per cent. in 1894 to 29 per cent. in 1939, even though during the same period copper production increased from 330,000 to 2,385,000 tons. A similar increase in proportion is found if aluminium output is compared with that of lead, zinc and tin. Aluminium has, therefore, advanced economically into the forefront

of the non-ferrous metals and, because of its low specific gravity (2.7) compared with that of copper (8.9), it is second only in importance to copper and competes in many spheres in which hitherto only copper and its alloys were used. The main metallurgical consumption of aluminium is either in the production of rolling or extruding alloys (slabs or billets) or, to a lesser extent, in the production of alloys for castings of various kinds.

Technical Development

While pure aluminium has an ultimate tensile strength of only 5-7 tons per sq. in. and a Brinell hardness of 24-32, it was possible by continuous development of the sand and chill casting alloys to improve them still further (precipitation and solution treatment at elevated temperature, cooling in air or quenching in hot water), and so to obtain a tensile strength of 15-20 tons per sq. in. for sand castings and 20-25 tons per sq. in. for die castings. The Brinell hardness of such alloys can be increased even to 120-140; this is especially important for pistons, a department in which the aluminium article has almost entirely displaced its cast iron competitor, although aluminium pistons do not reach the ultimate tensile strength (30 tons) and Brinell hardness (200-300) of cast iron, especially at elevated temperatures. The aluminium pistons, however, have three times better heat conductivity to carry off the heat of combustion, a lower weight (one-third of the cast iron pistons), and a better resistance to corrosion.

Many qualities have been discovered in the wrought alloys of aluminium whereby it can compete advantageously with carbon steel. The leading wrought alloys (some aged at room temperature and others heat-treated) such as Avional (Switzerland), Aludur, Lautal, Duralumin (Germany), Hyblum, 17 s, 22 s, 24 s, 25 s (U.S.A.), and RR 56, RR 59, Superduralumin (Great Britain) have, in comparison with a carbon steel of 0.35 per cent. carbon and 0.60 per cent. manganese content, the following properties:

	Wrought alloy	Steel (0.35 % C.)
Specific gravity	2.8	7.8
Heat conductivity	0.30—0.45	0.13
Electric conductivity	20—33	7—8
Ultimate tensile strength (tons/sq. in.)	18—33	31—38
Elongation (per cent.)	8—24	16—23
Brinell hardness	90—140	135—170

Since these physical properties compare favourably with those of the steel it is obvious that the low specific gravity of the aluminium alloys is of decisive importance, as it enabled aluminium alloys to be introduced into the construction of motor cars, ships, and aeroplanes. The much higher heat conductivity of hardened aluminium alloys has led to a large increase in the efficiency of internal combustion engines. The excellent electric conductivity, especially of the magnesium- and silicon-containing aluminium alloys, makes them especially suitable for overhead transmission lines.

The introduction of extrusions and thin-walled pipes of hardened aluminium alloys for every kind of building purpose has been found practicable for those parts which have only to resist impact strains. The elastic modulus figure, which gives an idea of the resistance to deformation of a workable material, is only one-third of that of steel with 0.35 per cent. carbon. The use of wrought aluminium alloys instead of carbon steel is therefore advantageous where elasticity is desirable.

Aluminium alloys plated with pure aluminium have proved successful where the qualities of the strong and hardened aluminium alloys have to be combined with the good corrosion resistance of the pure metal, especially for aeroplanes, ships, and motor cars, for the working of mines, in the chemical industry, and for the production of apparatus for the food industries. If an increase of the corrosion resistance is necessary it can be achieved by artificial oxidation of the surface (Anodising, THE CHEMICAL AGE, 1941, *45*, 1158, pp. 131-132) or with an additional varnish as a further protection.

Aluminium alloys are divided into a number of groups. The copper-aluminium-alloys were the first light metal alloys to be put to practical use, and copper is still the most important alloying constituent to be added to aluminium. The second place is taken by silicon, while zinc is of less importance, as it is only used for casting alloys with lower tensile strength. Magnesium, though likewise an important constituent, is seldom used as a main component, but is very often present in smaller quantities along with copper, silicon, and manganese. In an increasing proportion other metals have gradually been used for making aluminium alloys, and although the additions are small, the resulting physical and mechanical properties of the alloys are greatly improved.

Scientific Development

Since the beginning of the present century metallography has become so well developed that it is now possible to draw up the phase diagrams of many binary and of some of the ternary and quaternary aluminium alloys. Thus it became possible to lay the foundation for the systematic investigation of new metal combinations with aluminium, in which nickel, cobalt, chromium, titanium, and iron can now frequently be found, while lithium, beryllium, sodium, calcium, vanadium, columbium, molybdenum, cadmium, tin, antimony, cerium, tungsten, bismuth, and even thorium are intentionally added in special and particular cases.

From the metallurgical point of view silicon may be regarded as a metal. Therefore it is included in the following list of the 12 light metals other than aluminium, which are lithium, beryllium, boron, sodium, magnesium, silicon, potassium, calcium, rubidium, strontium, cæsium, and barium. The binary phase diagrams of these light metals with aluminium, with the exception of Rb, Sr and Cs, are established. Intermetallic compounds exist with lithium (AlLi), boron (AlB_2), magnesium, (Al_3Mg_2) and calcium (Al_3Ca). Besides the above light metals, there are 55 elements which can or could form binary phase diagrams with aluminium, among which 20 diagrams of the periods 1 to 3 are fully investigated and about 10 diagrams of the periods 1 to 4 which are only partly studied.

However valuable this knowledge of the binary phase diagrams may be, yet it is not sufficient because all aluminium alloys in industrial use contain at least two and often more than two metals besides aluminium and therefore the number of the actually possible combinations with the various elements is considerably increased. When scientists began to investigate this subject some 25 years ago, it was found necessary to employ the third dimension, as ordinary plane diagrams, as used for binary alloys, would not be capable of representing the true state of affairs.

Ternary and Higher Alloys

Theoretically 66 ternary aluminium alloys are possible, taking two of the previously mentioned 12 light metals at a time. Of these six are completely and three partly investigated. Theoretically also about 500 ternary aluminium alloys are possible with one light metal and one heavy metal, of which up to now 11 phase diagrams are fully and 19 diagrams partly drawn up. From about 1200 ternary aluminium alloys with two heavy metals which are theoretically possible, 11 diagrams are fully and 28 diagrams partly investigated.

In the same way about 6000 quaternary aluminium alloys are, strictly speaking, possible with one light metal and two heavy metals or with two light metals and one heavy metal, and about 14,000 various quaternary aluminium alloys are possible in combination with three heavy metals.

These figures show that the field of investigation here is practically inexhaustible, although the examinations of binary and ternary aluminium systems already made allow conclusions to be drawn for quaternary and five-component systems. But one cannot foresee the possible effect of minute quantities of other metals in any particular aluminium alloy, and to emphasise this it is only necessary to recall that often under 0.1 per cent. of a strange metal which dissolves in the aluminium crystals will completely change the structure. Examples are: (a) the "modifica-

tion " of the silicon-aluminium alloys by means of sodium; (b) the grain refinement by means of titanium; (c) the improvement of sea-water corrosion resistance by the presence of small quantities of antimony along with manganese in aluminium alloys; (d) the age-hardening and quenching of aluminium alloys containing intermetallic compounds, *e.g.*, magnesium silicide (Mg_2Si), thus causing the hardening of Dural.

On the other hand, the contrary effect, the forming of hard crystals in a soft base metal, as with tin, cadmium, or the enormously expensive germanium, combined with aluminium, would answer the conditions for aluminium bearing alloys. Germanium-aluminium alloys have, moreover, of all aluminium alloys the lowest eutectic melting point (423° C.) so that they may one day be used as solders for aluminium alloys. Lead also, with some addition of other metals, at present unknown, could be suitable for bearing metal alloys based on aluminium.

Intermetallic Compounds

Although the effect of intermetallic compounds, whose composition cannot be judged from their place in the periodic table, cannot be foreseen, a certain regularity can be established. The metals of the first great period allow the following intermetallic compounds with aluminium (mostly in the ratio 3 : 1): titanium (Al_3Ti), vanadium (Al_3V), chromium (Al_3Cr), manganese (Al_3Mn) [but also Al_7Mn], iron (Al_3Fe) and nickel (Al_3Ni); whereas cobalt (Al_9Co_2), copper (Al_2Cu), zinc (Al_2Zn_3) and arsenic (Al_2As_2) form different types of intermetallic compounds. Germanium, which belongs to the same period in the table of elements, does not form a compound with aluminium, but an eutectic alloy, containing about 55 per cent. Ge and 45 per cent. Al.

To the second great period belong the combinations of aluminium with molybdenum (Al_3Mo), silver ($AlAg_2$) and antimony (AlSb), while cadmium, apart from a small solubility of cadmium in aluminium, does not mix with aluminium either in the solid or in the liquid state. On the other hand, tin can be alloyed with aluminium in any proportion without forming an intermetallic compound and without showing distinctly the existing eutectic mixture, which lies at about 99.5 per cent. Sn and 0.5 per cent. Al.

From the third great period the following elements are known to form intermetallic compounds with aluminium; cerium (Al_4Ce), platinum (Al_3Pt), and gold (Al_2Au), while with mercury only an amalgam results, which quickly disintegrates in a moist atmosphere. With thallium, lead, and bismuth, there is only a slight solubility with aluminium in in the liquid state, while at their solidification a separation into two layers takes place. From the fourth period the existence of an uranium-aluminium compound (Al_3U) is recorded.

Beryllium Alloys

Among the binary light metal alloys, beryllium can be alloyed with aluminium in any proportion, without forming an intermetallic compound. The Al-Be diagram for low beryllium contents closely resembles the Sn-Al diagram for tin-aluminium alloys with a low aluminium content. Although the introduction of beryllium into aluminium alloys is facilitated on account of the solubility of the beryllium in the aluminium crystal, the useful results, which experimenters were led to expect from the analogy of the beryllium-copper alloys, were not achieved with beryllium-aluminium alloys.

In addition to the binary intermetallic compounds already mentioned, ternary intermetallic compounds may be found, as well as a number of binary intermetallic compounds between the various elements present in the more complex alloys. This is best illustrated by the zinc-magnesium-aluminium alloys, which show the binary intermetallic compounds, Al_2Zn_3, $MgZn_2$, Al_3Mg_2 and the ternary compound $Al_2Mg_2Zn_6$.

The more constituents an aluminium alloy contains the more complicated the question becomes and therefore luck as well as systematic research is bound to be involved in the further development of aluminium alloys.

Oxine Precipitates

Determination of Metals with 8-Hydroxyquinoline

THE use of oxine (8-hydroxyquinoline) for the precipitation of a number of metals is a well-established procedure; magnesium, aluminium, and zinc being frequently determined either by weighing the oxine complex of the metal or by bromometric titration of the precipitate. A disadvantage of the reagent is its non-specificity; nearly all the commoner metals, and some less common, can be precipitated by a suitable adjustment of the conditions. In some instances the precipitation is quantitative, in others only partly so. And although it is true that precipitation of one metal might be complete over one range of *p*H and that of another metal over a different range of *p*H, so that a separation of a mixture of the two metals should theoretically be possible over the *p*H range not common to them, this might not in practice be possible because of the formation of mixed crystals. The principal value of oxine as a reagent in quantitative analysis, in fact, as stated concisely by Knowles, lies mainly in its use after preliminary separations have removed interfering elements.

With the aim of realising in practice some of the theoretically possible separations, but bearing in mind the probability that the co-precipitations were in fact due to the formation of mixed crystals or solid solution, R. C. Chirnside, Celia F. Pritchard, and H. P. Rooksby, of the Research Laboratories of the General Electric Co., Ltd., have examined the state of a number of oxine complexes after drying at various temperatures (*Analyst*, 1941, *66*, 787, pp. 399-406). Gravimetic determinations were preferred to volumetric, and an effort was made to ascertain the composition of some of the hydrated precipitates and the correct temperatures for drying them to a fixed composition. A further investigation was made into the nature of co-precipitated oxine complexes. Analysis by the X-ray diffraction method was employed throughout.

Experiments were made with solutions containing magnesium, aluminium, zinc, and iron; also with zinc-magnesium and iron-aluminium solutions. The precipitates obtained with 8-hydroxyquinoline from solutions containing magnesium, zinc, iron and aluminium respectively were dried at various temperatures and the changes in weight at 98° C., 110° C., 140° C., and 160° C. were observed. The compositions were further investigated by the X-ray diffraction method. The anhydrous form of the iron and aluminium complexes is readily obtained at 98° C., but dihydrates of the zinc and magnesium oxine complexes are formed. The dihydrate of the zinc complex is substantially decomposed at 110° C., but that of magnesium is not completely dehydrated below 160° C. It is recommended that in gravimetric determinations the zinc and magnesium precipitates should be dried at 160° C.

The mechanism of the co-precipitation of magnesium with zinc and of aluminium with iron in varying proportions was also investigated. The work of Moyer and Remington (*Ind. Eng. Chem. Anal. Ed.*, 1938, *10*, 212), who put forward the view that co-precipitation might be due to adsorption effects, was repeated, but no evidence of adsorption was obtained. X-ray examination shows that co-precipitation can be attributed to the formation of solid solutions of the magnesium and zinc and of the iron and aluminium complexes. Under the conditions of the experiments the separation of magnesium from zinc, and of iron from aluminium, is possible only over a very narrow range of *p*H.

Tin Smelting in Rhodesia

Local Industry Started Satisfactorily

DEVELOPMENT, under war-time difficulties, of a tin-smelting industry in Rhodesia, is the subject of an interesting article in the *South African Mining and Engineering Journal* (1941, *52*, 2531, p. 683). Describing the opening and exploitation of the Kamativi tin mine in 1931, it is noted that since the opening of the property a considerable tonnage of the concentrates has been recovered, averaging 71 per cent. metallic tin, the chief sources being alluvial from the streams, eluvial from the rubble, and reef tin from the coarse greisenised pegmatites, while a small amount is recovered from quartz reefs. The bulk of the production is derived from the greisenised pegmatites. As yet the deeper reefs have not been developed, but it is the intention of the owners, on the exhaustion of the higher-grade pegmatites and richer rubble areas, to erect a large milling plant to take in the run of ores from these bodies. Component parts for the plant designed for this purpose are already being purchased. The owners of the mine recently purchased a Sullivan diamond-drilling machine, and it is their intention to start an extensive survey of reefs at depth, since as yet the proposition has merely been scratched on the surface, and full investigation has not been undertaken.

Experimental Problems

Until recently the entire output of concentrates was exported. Owing to shipping difficulties, however, a start was made, in a small way, last year to smelt the tin concentrates in Southern Rhodesia. This being the first industry of its kind in the Colony, it was found impossible to obtain skilled services, and recourse had to be made to trial-and-error methods. These experiments proved costly, but after the third attempt a type of smelting furnace was constructed which gave results sufficiently satisfactory to justify carrying on the venture. Present results are such that if cheaper rail facilities were obtainable the company would be in a position to compete in the Union market. As things are, however, they have to limit smelting production to the markets of Southern and Northern Rhodesia. Owing to the limited demand in these territories, the bulk of concentrates is still being exported overseas whenever shipping facilities are available. However, it is the hope of the Rhodesian Tin Refinery to be able to effect further reduction in overhead costs of smelting by the installation of a coal-pulverising plant to replace the costly crude oil fuel now being used. Although in its essentials tin smelting is fairly simple, it is a difficult matter to obtain a high percentage of initial recovery owing to several technical problems encountered. Experiments are still being carried on to improve initial recovery, which is now over 90 per cent.

Lead Production and Future Intentions

The Rhodesian Tin Refinery is also interested in the production of lead and has its own galena mine, the Mbanje lead mine, in the same area as the Kamativi mine. Galena is smelted at the mine and the lead sent to the refinery at Bulawayo for the manufacture of solder. The firm is now turning out solder equal to the imported article. This also, like the tin smelting industry, had its problems when operations were first commenced, but the experimental stage is over and the solder is being used from Beit Bridge to Elisabethville. It is the intention of this firm to manufacture also bearing metals, phosphor bronzes, and phosphor tin. This part of their activities, however, is still in the experimental stage.

The accumulated welding instruction information from the Lincoln Welding Schools has been gathered together in a book entitled "Lessons in Arc Welding," published by the LINCOLN ELECTRIC CO., LTD., Welwyn Garden City, Herts. The new book (176 pp., price 3s. 6d., post free) contains a series of 60 lessons which concisely present the fundamental facts of welding.

Cure for Steel Corrosion

New Australian Process

REMOVING from steel the scale or "mill bloom," which is the chief factor in corrosion, is the aim of a newly-developed Australian process, states the *Industrial Australian and Mining Standard*. It is to be applied to steel to be used by the Broken Hill Pty. Co., Ltd., at Whyalla, and is already operating on steel plates for the Morgan-Whyalla pipeline scheme.

The treatment consists of immersing the steel to be "descaled" in a specially constructed and heated bath. Within half an hour, it is claimed, the treated section has been freed of all adhering mill scale, and passes out to receive a coating of specially prepared structural paint before going on to the job where it is to be used. Results are described as superior to those achieved by sandblasting.

The presence of mill scale, which eventually lifts and breaks through protective coats of paint, is the main reason why ships and bridges have to be chipped and painted periodically at great cost.

The new process is already in operation in Victoria, New South Wales and South Australia, and it is said that most satisfactory reports have been received regarding results achieved.

Report on Wrought Steels

New B.S.I. Publication

THE British Standards Institution has just issued a very interesting report on wrought steels, complementary to the new En Series of specifications for carbon and alloy steels which has recently been published as B.S. 970. The report gives a description of each steel in the En Series indicating the purpose for which it is most suitable; details of mechanical test results obtained from steels having chemical compositions falling within the ranges specified are given, as well as notes about heat treatment together with an explanation of the effect of mass on the mechanical properties obtainable from the standard test piece. The 58 steels in the En Series are classified into 33 groups, and a section of the report is devoted to cross-referencing the steels in these groups to some 2000 specifications that have previously been in use in industry.

The report represents the work of the Technical Committee on Special and Alloy Steels which has been sitting in Sheffield for the past month under the chairmanship of Dr. W. H. Hatfield. Copies are obtainable from the British Standards Institution, 28 Victoria Street, London, S.W.1, price 7s. 6d., post free 8s.

Lead Pipes

Revised Standard Specification

REVISION of the British Standard for Lead Pipes has just been undertaken and is known as "B.S. 603—1941 Lead Pipes (B.N.F. Ternary-Alloy (No. 2))." This specification was first issued in May, 1935, but as a result of experience it was found that certain modifications were desirable, and these have been incorporated in the revision now published.

The main points in this revision are as follows:—

(a) The chemical composition is given in greater detail, also the method of marking.

(b) An additional clause has been included with regard to grain size.

(c) The ranges of pressure for which the various weights of pipe may be used have been modified; restrictions are also placed on the pressures in pipes used to carry hot water.

Copies of this specification may be obtained from the British Standards Institution, 28 Victoria Street, London, S.W.1, price 2s. (2s. 3d. post free).

General News——From Week to Week

The Red Cross Penny-a-Week Fund, contributed to by 5,000,000 small wage-earners, has reached a total of nearly £1,250,000.

Among the contributions to Birmingham's warship week were gifts of £25,000 from I.C.I. Witton Savings Group and £2500 from the County Chemical Co., Ltd.

A notice issued by the Ministry of Health requests that the utmost care should be employed in the use of phenol and its derivatives, *e.g.*, aspirin, salicylic acid, sodium salicylate, methyl salicylate, phenolphthalein, etc., so as to reduce promptly the quantity being used.

Laboratories and research workers throughout the world will be supplied by the National Institute for Medical Research, London, N.W.3, with synthetic racemic α-tocopheryl acetate ($C_{31}H_{52}O_3$), which has been adopted as the international standard for vitamin E.

The following firms have contributed to the Glasgow warship week: Messrs. Imperial Chemicals, Ltd., per Lord McGowan, £25,000; Milroy Chemical Company (interest free), £10,000; Fairy Dyes, Ltd., £5,000; Messrs. Brown and Adam, Ltd., bleachers and dyers, £10,000.

In answer to a question in the House, Mr. Harold MacMillan refused to give any information concerning the two officials of the Ministry of Supply, who were charged at Southend on October 16 with stealing and wrongfully disposing of 232 tons of molasses belonging to the Government.

The demand for chemical plant of all kinds continues to be a feature of the Scottish trade, with particular emphasis on autoclaves, filter presses, hydro extractors, mixing pans and stills. This demand is the direct result of increased activity in the war industries and will continue unabated for the duration of the war. A strong second-hand market is consequently developing with good prices for old materials.

Among the 339 additions to the list of persons in neutral countries with whom trading is illegal, contained in the Trading with the Enemy (Specified Persons) (Amendment) (No. 17) Order, the names occur of the Laboratorios Farmaco, S.A., San Rafael 807, Havana; Boehringer Productos Quimicos-Farmaceuticos S.A., Copernico 6, Barcelona; and Comptoir de Spécialités Pharmaceutiques S.A. (formerly André Junod S.A.) Rue de la Scie 4-6, Geneva.

Rich deposits of tin and wolfram at Cligga, near Perranporth, Cornwall, prospected a few years ago by Capt. T. Gribble and Mr. R. Rogers, of Chacewater, are now about to be developed by a new company, the Cligga Wolfram and Tin Mines, Ltd., financed by the Rhodesian Mines Trust. Headgear has been transferred to Cligga from the neighbouring Polberro mine, and a mill capable of treating 100 tons of ore per day, and modern dressing plant for wolfram and tin, have been installed. About 110 men are now employed.

Foreign News

Production of crude sodium carbonate in Egypt was 3500 metric tons in 1940, compared with 3750 in 1939.

Carbon tetrachloride exports from the United States for the first six months of the year reached a total of 1,508,700 lb. Hitherto production has been intermittent.

To conserve glycerine for cordite and ethylene glycol for anti-freezing purposes, the Canadian Government has prohibited the use of transparent film for wrapping civilian purchases.

Canadian imports of chemicals and allied products for August were valued at $6,224,547 and for the eight months ending in August $41,894,529. Exports for the same periods were $6,464,019 and $32,889,234 respectively.

A series of radio talks, sponsored by the Canadian Institute of Chemistry, has been proceeding throughout October in Canada. These talks are designed to give the public a better knowledge and appreciation of the contribution in chemistry, metallurgy, chemical engineering, and military explosives that the Canadian chemical profession is making towards the war effort.

An appropriation of $7,500,000 for the construction of a factory to produce butadiene was made in September by the U.S. Defense Plant Corp. The plant will be built at Baton Rouge, La., and operated by the Standard Oil Co. of Louisiana.

To meet the increasing shortage of alcohol in Thailand, the Siamese Government, early in 1941, is reported to have purchased in British Malaya a second-hand alcohol plant, which will be erected at Ayudhya, 75 miles north of Bangkok.

Refining of Tibetan borax on a larger scale in India is reported to be under consideration. The borax is imported into India in the crude state and refined in the United Provinces; between 6000 and 7000 cwt. are brought into the country annually.

The decree of July 31 prohibiting the export of zinc from Venezuela may, it is announced, be waived on certain occasions by government permission. For instance, the recent shipment of 168 tons of zinc scrap for the United States, at first held up, has now been allowed to proceed.

The announcement that sodium chlorate was actually being manufactured by the Brazilian concern, Industria Chimica Iguassu, as stated on p. 224 of this volume of THE CHEMICAL AGE, is premature. At present only an investigation into the possibilities of manufacture is being undertaken.

Creosote oil imports into the United States declined to 10,600,000 gals., valued at $1,241,600, during the first half of 1941 from 19,100,000 gals. at $1,875,000, in the same period of 1940. Canada supplied 4,400,000 gals.; United Kingdom, 4,100,000 gals., and Japan 2,100,000 gals. Exports advanced to 800,000 gals. from 165,000 gals.

Forthcoming Events

Dr. H. J. Plenderleith, B.Sc., Ph.D., F.R.S.E., will deliver a lecture on "Some Aspects of Museum Laboratory Work" before the London Section of the **Society of Chemical Industry,** in the Chemical Society's Rooms at Burlington House, W.1., on **November 3,** at 2.15 p.m.

At the opening meeting of the new session of the **Institution of Civil Engineers,** Great George Street, Westminster, S.W.1, on **November 4,** at 2 p.m., an address will be delivered by Professor C. E. Inglis, O.B.E., M.A., LL.D., F.R.S., President of the Institution.

The Society of Public Analysts and Other Analytical Chemists is meeting at 3.15 p.m. on **November 5,** at the Chemical Society's Rooms, Burlington House, Piccadilly, W.1, when the following papers will be read and discussed: "A Colorimetric Method for the Estimation of Small Quantities of Acetylene in Air," by C. Coulson-Smith, M.Sc., F.I.C., and A. P. Seyfang; "Deciphering Charred Documents: Some Recent Work," by Julius Grant, M.Sc., Ph.D., F.I.C.; and "Use of Ultraviolet Light for the Measurement of the Resistance of Paper to Penetration by Grease," also by Dr. Grant.

The Leeds Section of the **Institute of Chemistry** will hold its annual meeting in the General Lecture Theatre, University of Leeds, at 6.30 p.m., on **November 10.** Afterwards Dr. Dorothy Jordan-Lloyd, M.A., D.Sc., will lecture on "The Application of X-Rays to Leather Manufacture."

A joint meeting of the **Institution of Chemical Engineers** and **The Chemical Engineering Group** (Society of Chemical Industry) will be held on **November 11,** at 2.30 p.m., in the rooms of the Geological Society, Burlington House, London, W.1, when a paper on "Condensation of Water Vapour from Air" will be presented by Mr. M. Hirsch, M.Inst.Chem.E. The chair will be taken by the President of the Institution, Mr. C. S. Garland.

The Pharmaceutical Society of Great Britain will meet at 17 Bloomsbury Square, W.C.1, on **November 13,** at 2.30 p.m., when the Hanbury Medal will be presented to Dr. Harold King, D.Sc., F.R.S., of the National Institute for Medical Research. Following the presentation, Dr. King will speak on "Chemistry and Pharmacy." This is the first of a series of meetings to be held at 2.30 on the second Thursday of each month up to March, 1942.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for errors that may occur.

Mortgages and Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.)

PLANT, MACHINERY & ACCESSORIES, LTD., London, E.C. (M., 1/11/41.) October 4, assignment to District Bank, Ltd., securing all moneys due or to become due to the Bank; charged on contract moneys.

RUNCOLITE, LTD., London, W., manufacturers of plastic substances. (M., 1/11/41.) October 8, series of £10,000 debentures, present issue £5000; general charge. *Nil. December 31, 1939.

Satisfaction

BECK, KOLLER & CO. (ENGLAND), LTD., Liverpool, manufacturers of synthetic resins. (M.S., 1/11/41.) Satisfaction, October 1, of debenture registered April 14, 1936.

Company News

Genatosan, Ltd., have declared a final dividend of 15 per cent., making 25 per cent. for the year (same).

African Explosives and Industries, fertile manufacturers, announce a dividend for half-year ending December 15, on 5½ per cent. preference shares.

Erinoid, Ltd., announce a record profit of £61,795 for the year ended July 31, and have declared a dividend of 10 per cent. (6 per cent.).

Beralt Tin and Wolfram, Ltd., announce profit of £98,776 for the year ended March 31, an increase of £17,382 on the previous year, and are maintaining their dividend at 10 per cent.

Murex, Ltd., have declared a trading profit for the year ended June 30, of £553,091 (£490,440), and as already known have announced a dividend on the ordinary shares of 20 per cent., including a bonus of 2½ per cent.

A drawing of £19,590 of the 4½ per cent. first mortgage debenture stock of **United Glass Bottle Manufacturers, Ltd.,** for redemption on January 1, 1942, at par, will be made on November 20.

New Companies Registered

Harman Dietetic Laboratories, Ltd. (370,071).—Private company. Capital: £100 in 100 shares of £1 each. Analytical and consulting chemists, research workers, manufacturers of and dealers in dietetic preparations and food concentrates, etc. Directors: Maurice Gallant; Mrs. Doris Vandersluis. Registered office: 25 Harman Drive, London, N.W.2.

Luminous Fabrics, Ltd. (370,002).—Private company. Capital: £6000 in 6000 shares of £1 each. Manufacturers of and dealers in luminous paints, powders, compounds, cements, oils, pigments and varnishes, chemists, etc. Subscribers: R. Keedwells; P. J. Mills. Registered office: 1 Broad Street Place, E.C.2.

Penserve, Ltd. (369,735).—Private company. Capital: £1050 in 100 "A" shares of £10 and 200 "B" shares of 5s. each. Manufacturers of and dealers in chemicals, chemical substances and products, fertilisers, oils, dyes and varnishes, analytical and research chemists, etc. Subscribers: Sydney Thurston and S. Humphreys. Solicitors: Herbert Smith and Co., 62 London Wall, E.C.

J. V. Rushton (Coventry), Ltd. (369,977), and **J. V. Rushton (Redditch), Ltd.** (369,978).—Private companies. Capital, in each case, £100 in 100 shares of £1 each. Anodisers, metal finishers, electro-platers, lacquerers, enamellers, polishers and welders, manufacturers and dealers in chemicals, metals, nickel and other plating, polishing and finishing materials, etc. Directors: Florence Rushton; Florence W. Caddick. Registered offices: Conduit Yard, Fleet Street, Coventry, and Great Charles Street, Redditch.

Trade Products, Ltd. (369,518).—Private company. Capital: £5000 in 5000 shares of £1 each. Manufacturers of and dealers in chemicals, oils, colours, dyes and extracts, artificial manures, paper, pulp, cereals, farm produce, provisions, textiles, proprietary articles, etc. Directors: Reginald Gregg and Gordon Slater. Registered office: Lloyds Bank Buildings, King Street, Manchester, 2.

Chemical and Allied Stocks and Shares

ALTHOUGH the disposition to await the next turn of events in the Russian war news again prevented improvement in Stock Exchange business, the general undertone of markets has been fairly steady. Sentiment was assisted by President Roosevelt's speech and by the underlying strength of British Funds. The majority of recent dividend announcements of industrial companies compare satisfactorily with those of a year ago, despite the weight of taxation, and in most instances shares have remained firmly held and in short supply, with the result that, where demand improved, they were inclined to respond strongly in price.

Securities of companies in the chemical and kindred industries reflected the general trend, and Imperial Chemical, 32s. 6d. a week ago, have improved to 32s. 10½d. at the time of writing, while the 7 per cent. preference units were firm at 33s. 6d. Last year, the dividend requirements of the preference units were covered nearly four times, and the dividend on the ordinary units, which was again 8 per cent., was earned with a margin that would have paid a further 3¼ per cent. A moderate line of B. Laporte ordinary shares at 64s. 6d. has been available this week in the market, where the view prevails that there are reasonable prospects of the dividend being kept on a 15 per cent. basis. Fison Packard were inactive, but were again quoted at 35s., and elsewhere, Borax Consolidated deferred were better at 29s. 3d., a gain of 6d. on balance. The prior charge issues of the last-named company, which give apparently attractive yields, were in better request; the 5½ per cent. £10 preference shares transferred at £11⅞ at one time, and the 4½ per cent. second debentures changed hands around par. In other directions, rather more dealings were in evidence in British Drug Houses ordinary shares, which transferred up to 25s. Moreover, Cellon 5s. ordinary, which are firmly held, have changed hands up to 14s., following the announcement of the maintenance of the interim dividend at 10 per cent. Elsewhere, Morgan Crucible 5½ per cent. preference were dealt in up to 23s. 9d., and the 5 per cent. second preference at 21s. 3d. Monsanto Chemicals 5½ per cent. preference were again quoted at 22s. 6d.

Moderate fluctuations were shown in Lever and Unilever, which, however, have become firmer at 26s. 9d. at the time of writing, and among other leading industrials, firmness was shown by Murex at the improved level of 88s. 9d., following publication of the full results, which showed that trading profits increased further last year and that the lower net profits were due to increased provision for taxation. As already announced, the distribution of the last-named company is again 20 per cent., and this represents approximately half the earnings on the ordinary shares a further substantial addition being made to reserve funds. Among other securities, Tube Investments remained firm at 92s. 6d., awaiting the dividend announcement. British Aluminium were 44s., and British Oxygen moved better to 66s. 3d. Moreover, Imperial Smelting kept around 12s. 3d., in advance of the dividend decision and General Refractories 10s. shares were around their par value. Associated Cement showed a better tendency at 50s. 7½d., and there was buying of British Plaster Board, which were slightly higher at 17s. 6d. Pending the interim dividend announcement, Barry & Staines were inclined to improve, and at 37s. 6d. were 3d. better on balance for the week. Nairn & Greenwich were again 61s. 3d. At 27s. 10½d. Triplex Glass showed improvement on the week: while the better earnings recently reported by Splintex Glass tended to draw rather more attention to some of the other smaller-priced shares of glass companies. British Indestructo Glass were dealt in at close on 2s., and Forster's Glass changed hands up to the improved level of 19s. 3d.

Among shares of companies associated with plastics, British Industrial Plastics were dealt in around 3s. 3d., and Erinoid 5s. shares transferred at 5s. 3d. Lacrinoid Products 2s. shares were around 1s. 10½d. In other directions, following the recent announcement of the maintenance of the interim dividend of 3 per cent., Greeff-Chemicals Holdings 5s. ordinary have changed hands at 5s. 3d. Steadiness at 35s. was shown by Boots Drug 5s. ordinary, and Beechams Pills 2s. 6d. deferred were quoted at 9s. 6d. Following an earlier reaction, oil shares were inclined to improve in accordance with the surrounding tendency on the Stock Exchange.